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ABSTRACT

This paper identifies and discusses the connections between the way individuals frame their world based on the language they use and the impact of language and stereotyping on the perception that computer technology is primarily for certain individuals. The study explores how some of the dimensions of the language of computers and technology, computer culture, and computer-based activities are inextricably linked to the language and culture of mathematics which has framed a particular way of thinking about computer technology. The document discusses an array of anecdotal evidence and research findings supporting the contention that technology education carries with it the biases and beliefs of the society in which it operates. The use of computers often exacerbates inequities for students of color and poor students rather than act as an educational panacea. However, a broad understanding of this cultural context can be used to begin to change the culture of the classroom and school to respond better to the educational needs of the broad range of students who traditionally do not succeed. Questions are raised regarding, how to make technology engaging for both males and females and how can a new approach to technology support a democracy? The document concludes with a number of approaches to creating classroom changes. These include increasing the opportunities for girls to engage in technology-related activities, working with more collaborative activities, giving students' more control over the activities that they work on, and changing patterns of discourse. (MJP)

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Center for Equity and Cultural Diversity

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Working Papers Series

Gender, *Discourse,* and Technology

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Center for Equity and Diversity Working Paper 5

Gender, *Discourse,* and Technology

Katherine Hanson

Education Development Center, Inc.
Newton, MA

This is an extension of a paper originally developed by Katherine Hanson and June Mark, both of EDC, for presentation at the 10th International Conference on Technology at the Massachusetts Institute of Technology (MIT).

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Gender, Discourse, and Technology

The United States loves technology. Technology is seen as an autonomous process and an economic and pedagogical savior; computers and "high tech" innovations thus become quick fixes to educational problems (McCormick 1995). In an effort to keep up, families are rushing to purchase computers—in 1994 *Time* magazine reported that there are more than 15 million U.S. homes with both personal computers and school-age children.

There is a rush to put computers in every classroom. But this excitement often obscures the reality that technology and its promise are not equally available for everyone. Computer access remains primarily limited to upper- and middle-class families. Nearly half of households with a family income of $50,000 or more had a child using a personal computer (PC), compared to only 7 percent of those with incomes below $20,000; more boys than girls report using computers at home; and students of color are less likely to have computers (Scott 1995). And while efforts are made to increase interest in and involvement with computers, white females and people of color remain significantly underrepresented in technology-related careers.

Often efforts to change this imbalance focus on the students themselves, as if we need to "fix" the student rather than transform the complex structure and the many factors within it—psychological, social, attitudinal, and environmental—that serve to limit educational, career, and societal opportunities for females. As a recent study by Duke University concluded, "the underrepresentation of women in the sciences [is] not simply a function of a failure to attract women to the field, but also, and perhaps more importantly, a function of that climate . . . " (Lipson 1994). Until we explore the complexity of technology in education within the context of our cultural beliefs and norms, we will continue to perpetuate the inequitable distribution of access and outcomes for our entire population. For far too many students—white females, students of color, and poor students—technology and the promise it extends simply have no relevance to their lives.

If we place technology education within the context of culture, it becomes a dynamic process that can be and is continually shaped by the individuals in the culture. With a broader understanding of this cultural context and its norms, values, beliefs, and stereotypes, we can consciously begin to change the culture of the classroom and school to respond better to the educational needs of the broad range of students who traditionally do not succeed in our current system.

As language both reflects and shapes a culture, so too does the language of technology contribute to sustaining gender disparities in relation to participation in and continued study of technology-related fields. Here the language, often formal and distancing or hostile and violent, acts in subtle yet powerful ways to shape the perceptions and stereotypes of

uses and users of technology in our society. In this paper I attempt to build the links between the way we frame our world, based on the language we use, and the impact of language and stereotyping on the perception that computer technology is primarily for certain individuals. While I focus broadly on technology education, I assume that this means technology and education with the computer as the focus. This working paper attempts to explore how some of the dimensions of this language of computers and technology, as well as computer culture and computer-based activities, are inextricably linked to the language and culture of mathematics language and culture, which has framed a particular way of thinking about computer technology. It also looks at the reasons behind the stereotype of mathematics and technology as unsuitable for women and suggests underlying ways in which classrooms, families, workplaces, and other institutions contribute to the continued pattern of "no girls allowed." It raises questions about the very words we use and the style of conversation that may unconsciously include or exclude groups or individuals. Finally, the paper tries to pose questions for further discussion concerning the intersections of gender and technology, most specifically: how do we make technology engaging for both males and females and how can a new approach to technology support a democracy?

Technology Disparities

The shaping of a technology culture as exclusionary begins early and is well documented (Sutton 1991, Becker & Sterling 1987, Lewis 1987). Beginning in grade school, boys have more access to computers and use them more than do girls. For poor students and students of color, technology is often separate and unequal. Access to computers is seriously affected by the relative wealth of the school's student population. Schools with the lowest percentage of Title I students have the best ratio of student to computer (Scott 1995). Additionally, schools with large populations of students of color have an even greater disparity in computer use. Hayes (1995) found that "As with low-income students, students in schools with high percentages of multicultural [sic] students have less access to computers ... However, the disparity between high- and low-multicultural percentages is greater than the disparity between low-wealth and high-wealth schools." The more diverse a school is, the less access individual students have to technology.

These disparities begin to impact student choices. Fewer women still choose computer-related degrees. In 1990 women received about one-third of the bachelor's degrees in computer science, 27 percent of master's degrees, and only 13 percent of the doctorates. Women made up only 7.8 percent of computer science and computer engineering faculties, and only 2.7 percent of tenured professors (Spertus 1991).

The picture is similar for science and mathematics. In 1992 only 18 percent of engineers and scientists in the United States were women (and only 4 percent of engineers and

scientists were African American or Hispanic women). While women earned 52 percent of bachelor's degrees in 1990–91, they earned only 14 percent of degrees in engineering, 31 percent in the physical sciences, and 47 percent in math. Women earned 34 percent of all master's degrees and 28 percent of all doctoral degrees in science and engineering.

What Is Technology?

The discussion about technology often seems to be constructed as if "technology" itself were some magical source of power, a mysterious force that can control lives. The term is bandied about as if it were something new to the culture. Adherents see only limitless possibility, while those who question may be castigated as Luddites. Either way, the pervasive power of technology seems relentless—from the automatic teller machine to the home movie or video games.

But technology is not an invention of this decade or century. Nor is it just science. Throughout history "technology" has referred to the tools and systems with which humans control their lives. Frey (1989) defines technology as object (tools, machines), process (design and transformation of material), knowledge (know-how, technique), and volition (aims, intentions, and choices that link the other three). Musical instruments, forks, pencils, and snow shovels constitute technology as much as lasers and computers do. People have always used technology, but the word itself, and the image behind the word now convey a new meaning, synonymous with computers, laser beams, the unseen forces. As Postman (1992) points out, the design of the technology—its language, construction, and paradigms—both reflects the thought processes and perceptions of the designers and influences the way users think and construct their world. His work raises questions we need to address: Will we move toward a more "linear" way of thinking and behaving because of our interactions with computers; will we unconsciously adopt more violent, hostile language and processes because of the influence of messages from video games, television, and films? Or will we integrate synergistic humanistic thinking and models into the future design and use of computer-related technology? For example, if, as Postman suggests, the initial design of a technology reflects the thinking and learning style of the designer, the future users of that technology would most likely work within the original framework. If this is a linear, sequential process, then we as users may begin to assume that process as appropriate, eliminating the expectation or comfort with other thinking processes. In other words, the technology would train us to think and respond in certain ways. These and other questions will have significant influence on the involvement of females, males of color, students with disabilities, and poor students in this world.

Like the introduction of the printing press in the fifteenth century, computer technology is significantly shifting the way in which society today constructs itself. It will af-

fect, and be affected by, complex social issues: perceptions of gender, race, and class; beliefs about education, family, and the workplace. Any examination of technology and its relationship to gender needs to consider the question, "To whom will technology give greater power and freedom? And whose power and freedom will be reduced by it?" (Postman 1992, p. 11).

A Cultural Context

Technology education takes place within the context of a culture; both the school culture and the larger culture exemplify norms, values, and beliefs that form our attitudes and behaviors. Stanic (1988) suggests we need to ask "why there is differential access to experiences (i.e., stimuli and tasks) within our culture and whether this differential access is inevitable or simply inappropriate and unjust." We need to draw from the research on girls' development indicating that middle school girls may "silence themselves" and move more deeply into stereotyped ways of being. And we need to explore the impact of racism on systems and individuals as it influences classroom expectations, interactions, and access to technology. Finally, we need to include an understanding of the cultural perceptions of groups of students about education itself. Since individuals interact with the culture—accepting, mediating, or resisting certain cultural messages—it is important to explore "resistance" (Giroux 1983) among students and teachers to the dominant perceptions of gender-related expectations within technology.

Gender, Race, and Class

While the underrepresentation of females in technology is often cause for concern, very little thought has been given to the complex dynamic of gender, race, and class. One continued misconception is that gender issues are "girl" issues rather than part of a larger social problem that affects both females and males. If an environment is more welcoming to one group over others, that environment is not inclusive. Yet the imbalance in math, science, and technology classrooms, which remain predominantly white, male, and middle or upper class, is often accepted as a given. It is as if the other students, not the environment, must change.

What Is Gender?

Gender is a culturally defined concept, not a biological term. Gender as a concept includes "culturally determined cognitions, attitudes, and belief systems about females and males; it varies across cultures, changes through historical time, and differs in terms of who makes

the observations and judgments" (Worell & Remer 1992). Examinations of technology and gender need to be built upon an understanding of gender within this culture.

Paisley (1994) points to three perspectives concerning gender differences: unequal distribution of power, socialization, and inherent differences. Men as a group within U.S. society have more economic, political, social, and physical power than most women. Males and females are socialized to become different from one another; society continues to send gender-role messages that are different for boys and girls and create disparate psychological environments for gender development. Historically, those characteristics stereotyped as female have been dismissed as unimportant.

Race, Ethnicity, and Class

Similarly, race and class carry with them socially constructed roles, beliefs, and expectations. Students of color and poor students are often assigned lower status in schools, and the cultural, social dynamics of racism and classism play themselves out in the consistent underachievement of these students. The culture of technology is not neutral; it carries with it the biases and beliefs of the society in which it operates. The use of computers often actually maintains and exaggerates inequities for students of color and poor students (Sutton 1991). A shift to a more equitable paradigm requires the identification of "the features of Western sciences that have made them particularly attractive and susceptible to appropriation for racist and imperialist agendas" (Harding 1993). Students of color "risk being subjugated to the vicissitudes of scientific and technological forces which are as oppressive, demeaning, and domineering as are the socioeconomic and political forces of racism and exploitation" (Johnson 1993).

For many working-class students, technology with its accompanying language and curriculum (and the hidden curriculum of social mobility and professionalization) "signifies the eventual severance of the individual from her or his community" (Aronowitz & Giroux 1991). This may be too high a price to pay. To date, little attention has been given to how technology can support a strong connection to community and enable students to engage with technology without losing their identity.

The Culture of the Workplace

An initial expectation in this society was that gender stereotyping within technology would diminish following the development of microcomputers. As a new technology, computers had the potential to break the mold by becoming gender neutral. Instead, computers were quickly gender-typed as male territory within the workplace. Computer-related work was quickly gender-assigned. Word processing, as an extension of secretarial work, is "women's

work," whereas designing software is "men's work." For example, in many manufacturing industries, women are assigned to button-pushing work with computers while men are assigned the jobs that "meddle with the works" by working with the mechanism itself (Cockburn 1986). Technology language itself became a way to build connections among males and to exclude females. Workplace research in the mid-1980s discovered that "men form relationships through, and thrive upon, the mutual exchange of knowledge and a humorous competitiveness concerning technology. . . . Men continually define women as not technological. By this dual process they create a highly masculine-gendered social environment and a woman who cannot fit into it. Women are aware of the discomfort that would be involved for them in attempting to enter technological work and, in a sense, boycott it" (Cockburn 1986, p. 77).

The Classroom Culture

This workplace stereotype of computers as somehow "male" is often perpetuated by our schools, the place where many students first come into contact with computers (Wajcman 1991). Rather than entering classrooms through language arts or other disciplines, technology joined the school curriculum in math departments and "computers became part of the landscape of the male domain" (Sadker & Sadker 1994). The math-technology link is further strengthened as computers tend to be reserved for high-achieving students, especially those who are good in math (Ascher 1984).

Within the workplace as well as within education, computers seem to have a separate culture and language that are perceived to be quite formal and rigid. Given that computers are not inherently biased, these current perceptions have been formed by people's experiences. This situation points to the need for care in creating an appropriate and equitable context and culture for computers in schools. When students interact with computers in schools, what are they really learning? Using ethnographic methodology, Jungck (1990) examined how students are socialized concerning computers, and raised the question of what students really learn via the hidden or implicit culture (Apple 1979) that teaches them the norms and values of the school culture.

When computers are placed in mathematics classes, the culture of the class reflects a reality that this remains a male-dominated area. The majority of computer-using teachers are male, and few female role models exist to counter that image. As in the workplace, the technology culture in the classroom is maintained by a language of aggression and competitiveness (Tarlin 1995) and a reveling in technology for technology's sake. All of these qualities run counter to the language and relational values of most females. As Jungck (1990) asks, "since White, college-bound males predominate in programming courses, might the subtle or hidden curriculum for that student be one of socialization into the expectation

that he will be in a position of power or control over computers?" Perhaps another part of the message is that he will be in a position of power or control over other people as well.

Girls continue to feel less comfortable with computers and like them less than boys do. Cornelia Brunner and Margaret Honey of Education Development Center's Center for Children and Technology (CCT) found that boys describe technology in more positive terms than do girls; boys find computers "enjoyable," "special," "important," and "friendly." If girls do not express the same comfort level, it is because they continue to receive the subtle and not-so-subtle messages from parents, teachers, peers, and society that technology is a predominantly male domain in which they are not welcome.

Both the education and workplace culture are predominantly white and mainstream, formed by unconscious beliefs, stereotypes, and attitudes. Unless these issues are addressed directly, teachers will unconsciously impose a "well-developed world view about the nature of society and inequality which is based on their life experiences and interpreted through dominant modes of thought. Their world view provides guidance as they make decisions about how and what to teach; and it serves as a filter" (Sleeter 1995) that can prevent them from seeing or acting upon inequities in the classroom.

Students themselves come to the classroom with their own beliefs and stereotypes and tend to rely upon their individual experiences to define gender, race, class, and ethnicity. Students, especially those who learn to play the dominant game and are rewarded with "honors" classes, are not necessarily willing to change the rules of a technology classroom that maintains gender, race, and class differences (Martin 1995). Students who are not "successful" in playing the game do not even have a voice in the discussion.

Talking the Culture: Technology Discourse in the Classroom

If a graph could say "I love you," if it could sing a child to sleep,
then from this struggle I might find some benefit to reap.

But all this wishful thinking only serves to make things worse,
when I compare my dearest love with your numeric verse.

For if mathematics were a language, I'd succeed, I'd scale the hill
I know I'd understand, but since it's not, I never will.

(Turkle 1988)

This female student's poetry captures many girls' feelings about mathematics and, by extension, technology. Rather than seeing the "computer as Rorschach," in which computers represent "an ambiguous material that encourages the projection of significant inner differ-

ences" (Turkle 1988)—a tool for creativity like paints, pencils, and clay—many girls and women see computer technology as alienating. Mathematics and computers are seen as antithetical to women's ways of knowing, counter to what Gilligan describes as the "web of connectedness." The resistance of many females to technology may be related to the perception of mathematics and technology as emotionless and disconnected from human interaction—a perception shaped by the discourse (conversation) of the classroom.

Discourse is formed by both the teacher and the students and by the discipline work they are doing. In their role as teachers, adults send strong signals about knowledge and what ways of thinking and knowing are valued. The ways in which this discourse is shaped have a significant impact on how students will construct mathematical knowledge.

Without "explicit attention to the patterns of discourse in the classroom, the long-established norms of school are likely to dominate—competitiveness, an emphasis on right answers, the assumption that teachers have the answers, rejection of nonstandard ways of working or thinking, patterns reflective of gender and class biases" (Ball 1991). This cautionary note is particularly critical to girls, who have traditionally remained outside the standard discourse patterns of mathematics classes. The implications for discourse are considerable since the "classroom environment, or culture, that the students and teacher construct affects the discourse in some important ways. The environment shapes how safe students feel, whether and how they respect one another and themselves, and the extent to which serious engagement in mathematical thinking is the norm" (p. 45).

Focusing on the discourse—what is said and how it is experienced—in the classroom requires an awareness of the context of the discourse as well as the content. This context includes the discourse leading to the question or current discussion, the previous participation of speakers, and the relationship among the speakers (Carlsen 1991). In technology classrooms this would include the belief systems, communication patterns, and socialized modes of behavior within which the classroom operates, especially those gender-role stereotypes concerning academic achievement ingrained in children from early childhood.

From a sociolinguistic perspective, student achievement on performance tests is not the primary focus of the conversational interactions; rather, it is the linguistic outcomes—how individuals make meaning of self and society through language. Teachers and classroom researchers, however, focus on immediate objectives, like stimulating participation in discussion. But it is the very nature of the discussion that may determine achievement outcomes. The context of discussion, the content of the discussion and the responses and reactions of teachers and students either support or challenge a "hidden curriculum" that reinforces gender-role stereotypes.[9]

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[9] The field of sociolinguistics is beyond the scope of this paper. However, since it is relevant to the classroom

The dynamics of classroom discourse depend on everyone knowing the rules, however unconsciously. These rules are the typical arrangements of speakers and listeners with associated rules for participating in the discourse (Philips 1972). The rules must be understood by all speakers, or miscommunication results. This requirement is particularly evident in cross-cultural classrooms, where one discourse style might be perceived as an embarrassing intrusion by a student from another culture (Carlsen 1991). Less evident is the miscommunication and tension that result when the discourse style is one that excludes female participation.

Leder (1987) claims that, within the classroom, " Differences in interaction patterns . . . are likely to result in both affective and achievement-related attendant differences." Boys, as the focus of the discourse, are therefore more likely to develop a strong task-intrinsic motivation (typical of high-achieving students), while girls are more likely to develop a less functional behavior of working for teacher approval.

By exploring the socialization of discourse for males and females, the pattern of discourse in technology classes takes on a new light. If the accepted mode of discourse is a questioning/challenging model that highlights individualism and competition, where do girls socialized to a more collaborative, passive mode fit in? What impact does this have on boys who are not comfortable with a confrontational model? A critical question that needs to be examined is what happens when girls are challenged within a technology classroom. If they have not developed adequate process skills to enable them to be comfortable with their own technological abilities, the challenge from the teacher to explain a process or to take the lead—which might be seen by males as a positive motivator—may in fact put a girl on the spot, and instead of motivating her to excel, may have just the opposite effect.

When girls are socialized early into playing a secondary role in the discourse, the sudden thrusting of an individual into the discussion may be too threatening to an emerging sense of self. In discussions with adolescent girls, Bell (1989) found that even those girls who know the answers are careful not to appear "too smart." Her respondents talked about knowing girls weren't supposed to be smarter than boys, as well as not wishing to be singled out as being separate from their community of other girls. For these girls the collective is more important than individual competition, and they described ways in which they made themselves invisible within the classroom.

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discourse, readers may wish to further explore the variety of sociolinguistic research in Crawford, M. (1995) *Talking Difference: On Gender and Language*. Thousand Oaks, CA: Sage; Brown, G., & Yule, G. (1983) *Discourse Analysis*. Cambridge, England: Cambridge University Press; Cazden, D. B. (1986) Classroom discourse. In M. C. Wittrock (Ed.), *Handbook of Research on Teaching* (pp. 432–463). New York: Macmillan; Farrar, M. T. (1988). A sociolinguistic analysis of discussion. In J. T. Dillon (Ed.), *Questioning and Discussion: A Multidisciplinary Study* (pp. 29–73). Norwood, NJ: Ablex; and Philips, S.U. (1972) Participant structures and communicative competence: Warm Springs children in community and classroom. In C. B. Cazden, et al. (eds.), *Functions of Language in the Classroom* (pp. 370–394). Prospect Heights, IL: Waveland.

If teachers feel that participation is an indicator of learning, students who do not actively participate are seen as not learning and are often then made invisible; excluded from the ongoing learning process, they in fact do not learn—at least not what is being consciously taught. In a classroom that encourages traditional form of argument (debate) and individualism, boys, particularly white, middle-class males, will feel most comfortable participating. Girls, socialized not to distinguish themselves from the group and fearing that they will be judged by their verbal gymnastics, will be reticent to participate in the debate. Girls who do feel comfortable asserting their individual views may be silenced by both the male students and the teacher.

However, since the classroom remains the training ground for adult public discourse (the workplace, politics, meetings), girls also need to develop a comfort with and skill in public debate/discussion and with individual leadership even if they must choose another model as their primary discourse mode. As women within a public arena, they must be able to participate and understand the rules even as they change them. It is essential, then, to find ways to restructure the discourse model to include different forms of communication, in addition to traditional debate. This new form of discourse is consistent with the education reform agenda and may in fact evolve into a different kind of technology language.

Research and practice have often focused on what can be done to girls rather than what can be done to education to increase girls' participation. Burton (1990) reiterates that this is a complex discussion that includes five aspects of research: the numerical presence of females and males, the subject distribution of females and males, female success rates, learning climate, and similarity of experience. This last aspect—whether males and females have similar experiences within the classroom—needs further examination. For although many educators strive to provide the same experience to all students, the research literature continues to challenge the assumption that it is possible to do so. In fact, many female students are having an experience very different from their male colleagues. Any discussion of similarity of experience in the classroom must also extend to the social context of that classroom. While the underachievement of females may not show up until high school, the process of creating different experiences for males and females is a pattern of socialization that begins in early childhood and is reinforced with each life experience.

Gilligan (1982), Belenky et al. (1986), and others have suggested that females most commonly utilize a "connectivist" mode of thinking. The traditional mode of education—with its level of abstraction from human context—is thus both alien and alienating to them. For many females mathematics and technology language, its discourse mode, and classroom dynamics run counter to the way in which they are socialized to interact and communicate. On the other hand, males socialized toward an individualistic perspective may be more comfortable with "interaction based on individual expertise and presentation and elaboration of abstract concepts" (Kramarae & Treichler 1990).

Further research needs to examine the link between socialization and the decline of self-esteem and academic achievement that occurs for many girls beginning in middle school. If the unconscious messages to girls have created a stereotyped mental model of adult femaleness that focuses on the body rather than on the whole person or achievement, it would seem that young girls are less likely to choose the path to visible social (academic) achievement; and when they do, it is unlikely to be in mathematics or technology. Gilligan reminds us, the world at large and, by extension, education, sends a message to girls to "keep quiet and notice the absence of women and say nothing." How this message plays out for girls from different racial, ethnic, cultural, or economic backgrounds still needs considerable research.

"Technology Is Not for Girls:" Teaching Technophobia

The gendered messages about technology, like those about math and science, are clear, and students internalize them. For example, both male and female students in one study (Michigan State Board of Education 1991) felt comfortable in defining mathematics achievement as primarily for males. They agreed that math, science, and gym favored males ("boys like gross things," "girls could care less about spiders, ticks, and mice"). The students claimed girls avoid advanced computer classes because "they don't want that brainy image" and felt that boys excel at formulas and structured learning. Their explanations conformed to traditional gender stereotypes: Girls only need math for grocery shopping; "girls can't get into science the way boys do because it just doesn't have anything to do with their future or careers." These responses reflect the perceptions of students throughout the country and show that the myth that math, science, or technology are not for girls remains prevalent among both males and females.

This perception is backed up by the finding that liking a discipline is a primary factor in whether or not students do well. For example, students who say they like mathematics perform better on math tests (Lockheed et al. 1985). The liking or not liking of a particular class is based in part on a student's feelings of success within that class—feelings based not just on academic achievement but also on experiences in the class. Campbell (1986) found that girls' confidence in themselves as math learners, their perception of math as a difficult subject, and their view that math is a male activity all have an impact on girls' attitudes, achievement, and participation in advanced courses. Girls who do not see mathematics as an exclusively male domain tend to have higher math success. When the dynamic is changed to make mathematics accessible to both girls and boys, girls' interest and involvement rise. A student's belief that mathematics has utility in her or his life (Fennema & Sherman 1978) and the teacher's belief that students should be active partici-

pants in learning and doing mathematics are also important components in building an affinity with mathematics.

These findings are closely linked to what happens in technology. For instance, in a study of gender-related involvement with LEGO TC Logo, middle school girls' interest and involvement with LEGO TC increased considerably when they were placed in mixed groups and given the key roles of keyboarder and spokesperson (Cutler-Landsman 1991). Initially, although girls were included as active learners in all groups, the projects students undertook did not seem relevant to girls, and they quickly lost interest. However, when the structure was changed to truly integrate girls and boys into team projects and to provide girls with an opportunity to select projects, girls began to express considerable interest because they had the opportunity to learn from the boys' expertise in LEGOs. The change in classroom structure, placing girls in a position of relative power and importance as spokespersons, enabled them both to familiarize themselves with computer language and to develop the skills and confidence to *"explain the project and reflect on the problem-solving strategies* (emphasis mine) their group employed."

Research conjectures that females tend to have a "fear of success" in those situations they see as predominantly male domains. Although later reinterpreted to indicate a general fear of success among women, the original research surfaced the anxiety women experienced as they moved into what was for them at the time the nontraditional setting of the corporate world. Like these women, young women today are moving into another nontraditional arena—mathematics—where the rules and assumptions remain a mystery. Providing girls with the opportunity and skills to be a public presence may be at the core of the long-standing disparity in mathematics and science achievements between the sexes. If males are socialized for public speaking while females are socialized for private speaking (Tannen 1990), then a classroom dynamic that addresses the issue of discourse along with mathematics content will be more successful for females.

Math anxiety and technophobia are learned responses—girls are not born hating mathematics (Fox 1981). Girls are socialized to avoid risk taking from the time they are very young—and in the culture of the United States, mathematics or technology may be seen as risky business for females. Additionally, parental expectations of girls and boys differ significantly. Socialization based on these unconscious stereotypes and expectations begins early and influences a girl's decision whether or not to take specific courses in high school. Parental expectations influence course choices and parents are more willing to invest greater sums in their sons' education. Such attitudes, often unconscious, help to perpetuate the assumption that girls cannot excel in mathematics or technology.

This socialization pattern continues in school where the "hidden curriculum" that trains white males for public discourse and success is carried out. Whether as a result of unconscious behavior patterns and expectations, outright hostility to girls on the part of

teachers and male students, or the lack of encouragement from guidance counselors, this process of disengaging females from nontraditional careers continues. Although there are numerous successful programs to change girls' attitudes toward technology, these programs often remain outside the traditional classroom. Further research needs to determine whether these self-contained programs can have the same results within the mainstream classroom or whether we will continue to repeat the old pattern.

This points to the importance of what actually happens in classrooms, particularly in terms of teacher-student interactions and both teacher and student expectations. It is within the classroom that the importance of examining gender-role expectations and socialization converge and often unconsciously influence both the curriculum and the real experiences of the students. It is therefore helpful to explore the control of discourse as a way to examine how socialization is reinforced and its impact on education. This teaching-learning point needs further research.

Yet many teachers feel they are treating their students fairly. Spender (1982) quoted a teacher who discovered that she spent only one-third of her time interacting with the girls: "But I thought I spent more time with the girls." Her assumption was reinforced by comments from the boys in her class, who complained that she spent all her time with the girls. While teachers continue to focus their attention on male students (Spender 1982, Sadker & Sadker 1994) there seems to be a maximum level of involvement beyond which boys and their teachers unconsciously feel that girls should not participate. Although the perception may be that girls are participating in the discourse, in fact they are not. The implications of this assumption that girls are not entitled to equal participation in discourse are enormous. Although they may be well prepared for written work, girls at the elementary level are already prepared not to participate in the larger public discourse necessary for success as adults.

The relationship between curriculum and discourse needs to be considered in any examination of achievement for girls. The ability to participate in the classroom conversation is inextricably linked to writing and reading, and they in turn are linked to the other areas of the curriculum. If girls are prevented from participating in the public discourse of the classroom, they will continue to excel only in that segment now seen as personal and relational—creative writing and composition—without developing the ability to interact with peers to develop their ideas or to use writing as debate/dialogue. The systematic, although unconscious, exclusion of girls from group and class talk denies them an opportunity for successful learning. Knowing they are excluded from the dialogue, girls may also develop alternative learning strategies that work well at the elementary levels but put them at a disadvantage later (Claire & Redpath 1989).

Within this context "girls may as a group be given less privileged access to certain kinds of learning experience. Secondly, classroom talk forms an important arena for the re-

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production of gender inequalities in interactional power. In arriving at the second conclusion we can observe that the . . . ideal that schools exist to teach pupils how to take their 'proper' position in the social order may still, at least in one respect, hold true" (Graddol & Graddol 1986). The control of discourse within the classroom plays a significant role in teaching girls and boys their proper role within society. Until we change that discourse, we will continue to ensure the underachievement of females. With this in mind, we need to determine how and when students are socialized into this model, as well as examine the purpose of gender-role stereotyped discourse.

Shifting the Classroom Discourse

For the last few decades researchers have explored the ways in which men and women communicate—or miscommunicate. Coates describes seven areas in which adult men and women have problems communicating (Coates 1988, cited in Claire & Redpath 1989). This research, like the work of others, showed the following:

1. Women use questions more than men as part of a general strategy for conversational maintenance. Men, however, interpret questions as simple requests for information.
2. Women begin their turn by acknowledging the contribution of the previous speaker and then talk to a topic directly connected with what preceded. Men are more likely to ignore what has been said before and to concentrate on making their own point.
3. In all-male conversations there are abrupt topic shifts, with elaboration and continuity being irrelevant. Women build on each other's contribution, shifting topics gradually.
4. All-women conversations are "therapeutic" in that women use conversation as an opportunity to discuss problems, share experiences, and offer reassurance. Men respond to another speaker's disclosure as if it were a request for advice and so often act as the expert offering guidance.
5. For men, loud aggressive argument, often on trivial issues, is part of the conventional structure of conversation. Women are uneasy during such displays and interpret them personally and as a disruption of the conversation."

"I would attach a cautionary note to this observation, since there are significant cultural, ethnic, and class differences in discourse styles. The question here concerns the discourse mode within the classroom, which tends to be predicated on a white, male, middle-class model.

6. Women offer enthusiastic comments, nods, and minimal verbal responses during another speaker's turn. Men routinely interrupt to seize a turn and deny the current speaker's right to complete a turn.
7. Active listening by women is seen by men as women's failure to assert their right to speak; women feel men ignore their contribution to the conversation.

For many educators, the impact of a prior unconscious socialization pattern that literally prevents girls from participating in their own education is often overlooked, as are the implications for the classroom. Even linguistics researcher Deborah Tannen initially did not think about her own teaching (to university students) in light of her research: "the furthest thing from my mind was reevaluating my teaching strategies." Her teaching style, opening discussion of readings by asking, "What did you find useful in this? What can we use in our own theory building and our own methods?" contrasts sharply with that of a male colleague. He said, "I have students read an article and then I invite them to tear it apart. After we've torn it to shreds, we talk about how to build a better model" (Tannen 1991).

Another of her male colleagues discovered that he had always taken for granted that the best way to deal with students' comments was to challenge them. Tannen recounts "This, he felt, was self evident, sharpens their minds and helps them develop debating skills. But he had noticed that *women were relatively silent* in his classes" (emphasis mine). When he switched to encouraging discussion with relatively open-ended questions and letting comments go unchallenged, he noticed more women participating (Tannen 1991). When the expected mode of discourse may in fact be debate, those females who attempt to participate in the debate are often then excluded for participating in ways not seen as appropriate for their sex. The woman who is aggressively intellectual does not receive the same acclaim as her male colleagues do. If females and males are socialized to a very different set of discourse patterns, the overreliance on one discourse model (the white, middle-class, male debate model) effectively excludes females from the opportunity to build their own thinking within the public domain. A shift in the discourse mode could begin to change the pattern of involvement and achievement.

Research indicates that individuals adjust their verbal and nonverbal patterns to mirror the behavior of others whom they like, wish to like them, or see as having the power to reward them. In the case of students, the teacher maintains a great deal of power; additionally, girls who are often dealing with issues of self-esteem also adopt behaviors that will "make the boys like them." Within the classroom, this encourages girls to assume a traditional conversation pattern based on gender-role stereotypes.

The very language of the discourse plays into gender-role socialization. As Damarin (1990) points out, for many centuries mathematics was the arena of men, and its language

reflects that in its references to aggressiveness—mastery, power, hierarchies of objectives. This language of aggression, coupled with the emphasis on abstract activities that characterizes much of current math instruction, may in fact silence females within the mathematics discourse. Like Gilligan and Belenky, Damarin points to the need for a sense of connection in order to make females feel involved in their education:

> women learn abstractions (such as mathematical principles) best if statements of rules are preceded by quiet observation, by listening to others, and by personal experiences that women can relate to the abstractions. The personal mathematical experiences through which females understand abstractions often differ from those of males.

As in mathematics, the language and culture of the sciences remain masculine gendered (defined as a socially constructed characteristic assigned to males in this society). Bleier (1986) points out that the language scientists use often invites the reader to supply the relevant cultural significance that the data they present would fail to support. The language, dominated by unconscious assumptions of male authority, does not allow readers to see things in any other light. The image of scientist as a male authority is supported by the public discourse; the patterns of words scientists use in public speaking and in research articles "project an image of impersonal authority and absolute confidence in the accuracy, objectivity, and importance of their observations" (Namenwirth 1986). Women scientists "often call attention to the limitations of their data, to potential flaws in the experimental design, to control experiments that remain to be done. They engage in a kind of public criticism of their own work, taking pains not to overstate their findings or deceive the audience" (p. 23). The impact of this on outcomes for women is explored by Namenwirth (p. 19) who says,

> it is essential to realize that *covert, subtle* forces can be exceedingly effective in shaping human behavior. When girls and women are gently discouraged from fully developing their intellectual and creative potential, when they are subtly distracted from seeking positions of power and prestige, the result is the sifting out of all but the most determined minority of women. . . . Those who remain consequently operate in arenas dominated by men, where women are unusual, hypervisible, suspect, frequently patronized, and sometimes ostracized.

The Classroom Dynamic

When Rafaela Best first began her research for *We've All Got Scars*, she focused on the development of the boys, since nothing much seemed to be happening with the elementary school girls. They were "girls acting like girls." In other words, girls were already "little women" who maintained their assigned role of helper. However, as Best explored the gender-role socialization, she discovered that although most girls were already acculturated to

their assigned roles, those who wanted to achieve status in class chose "to be boys." Since gender is a social as well as a biological phenomena, little girls who could outperform boys in physical and social acts (sports, fighting, swearing, mathematics, etc.) could seek admittance into their world; they were accepted by both boys and girls *as honorary boys*. They are not seen as girls who are as good as boys, but rather as a new kind of person; perhaps they are seen as androgynous.

Little boys who were not accepted by the other boys, however, did not have the option of choosing to be girls. Any announcement of the assumption of female gender, based on the assigned roles, was met with derision and disbelief by both boys and girls: Who would want to be a girl? Boys who wanted to participate in the conversational/social interactions assigned to the girls were simply not allowed to. At this relatively fluid time in a child's development, therefore, girls do have the option to try on the other gender and, by association, take on a role of power. For those elementary school girls who see themselves as "tomboys" and excel in such "boy" activities as mathematics, the shift to more clearly defined gender roles that comes with middle school again forces them to attempt to define who they are in terms of academic achievement. For many the stress of being nontraditional is too great, and they retreat with the rest of the girls who remained "girls" into a world of nonparticipation in those areas—like mathematics and technology—most clearly defined as male.

Research (Sadker & Sadker 1985, Rosenthal & Jacobsen 1968), has shown that the teacher's control of the discourse is based on unconscious patterns of expectation, which are influenced by the race, class, and gender of the student. White males receive the most positive attention within a class; they are also pushed to think, to expand their ideas, and to defend their positions. In other words, they are being prepared to succeed in the world of public discourse; the classroom discourse is preparation for adulthood. African American students receive more negative feedback for behavior and more positive-negative feedback (comments that begin as positives but include a negative modifier, thus sending a mixed message). Here Delpit can be most instrumental for understanding and addressing the issue of discourse and race (Delpit 1988). Additionally, females receive significantly less total communication, less praise, less feedback for negative behavior, and less nonacademic feedback. And white females receive less total communication feedback than all other groups (Irvine 1985).

Irvine (1985) points to considerable research* showing that the patterns of gender-role stereotypes are so ingrained as to remain invisible. Teachers see girls as objects of attachment rather than of concern; they perceive girls more favorably—because they are not

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* For further discussion of teacher interactions, differential expectations, and student self-identity and achievement see Brophy & Good 1970, Brophy & Everton 1981, Brophy 1983, Aaron & Powell 1982, and Simpson & Erickson 1983.

attracting attention, acting out, or otherwise participating in the activity of the classroom. As in the preschool setting, teachers initiate more contact with boys, and boys are more likely to call out answers. While girls are less likely to call out answers, teachers also respond significantly less to their attempts to initiate conversation. In this pattern of control of discourse, it is not even necessary for males to have the right answers but merely to be noticed and engage with the teacher. Sadker and Sadker (1985) found that at all grade levels and in all subjects, females have fewer opportunities to interact. Unfortunately they also found educators to be unaware of the impact of this pattern of bias. When all dynamic remains unconscious, it prevents girls from being active participants in their education.

A classroom structure that encourages patterns of discourse based on male stereotypes—independence, dominance, and acting as a leader—plays out a model with which many women feel uncomfortable and excluded. Yet teachers continue to define questioning as the "quintessential aspect of teaching." While asking questions may be critical to knowledge acquisition, we need to explore the ways in which questioning, as opposed to the verbalization of the question, can be developed in both males and females, and the ways in which different questioning methods can be respected and supported within the classroom discourse.

While males engage in the classroom discourse, females write papers. This may enable women to earn good grades, but they miss out on mastering the thought process and may be left with only surface knowledge. The role of writing is played out differently in the humanities and social sciences, where females have long been more active and comfortable. The role of writing in technology for the most part may not play the connective role it does in other areas.

If technology remains a language for action and expression that is predominantly male, females will continue to be excluded from the discussion. Women who do not share this technological world view will simply be silenced. They will not have the language or connections to the unspoken discourse modes needed to participate (Benston 1990). As long as the discourse of technology is dominated by males (characterized by facts, rules, and technical matters) females are at a disadvantage (Spender 1980). Males often have more expertise in a wide range of technological areas than females do. This shared expertise then controls the conversation, as Benston (1990) explains:

> Control over and understanding of technology is only one facet of that expertise but it is an important one in a society increasingly technologically based. The areas of male expertise are defined by them as the only legitimate areas of concern; women's whole realm is dismissed as unworthy of serious notice. The resulting communication between men and women is then largely asymmetric and women's contribution is often mainly that of finding topics that men want to discuss.

If female students are excluded from that construction, they cannot move into the conversation later as part of their careers. For many women the discourse of technology can become another equivalent of "sports talk," which remains within the male domain. For those women who attempt to enter into the discourse as equals by adopting a male discourse model, the response is no better. Unlike the girls in Best's study, women are often penalized for attempting to participate in the "male domain." Often, the perception of behavior is confused with actual behavior, based on gender-role stereotypes. While a man might be called ambitious, assertive, or independent, a woman displaying the same behaviors is often labeled aggressive, pushy, and argumentative. Studies continue to show that when women and men exhibit the same behavior, that behavior is devalued for women (Pearson 1987).

Cyberspace and Computer Games

If the "not for girls" message pervades the workplace and the classroom, do girls fare any better on the Internet or with computer games? Research shows that it is not much different in cyberspace. Computer company executives and software designers are predominantly male; video games, also designed mostly by men, are dominated by images of competition, sports, and violence. Tarlin (1995) reports that 74 percent of the characters in computer games are male; in addition, any female characters are usually damsels in distress needing to be saved, or else they are victims. Span (1994) tracks the changes that are occurring in her look at cyberspace. Although they are still heavily populated by men, women's representation on the various networks is growing. Most on-line services have very few female subscribers (although women and children may log on using men's accounts). Most of CompuServe's 1.5 million subscribers (90 percent) are male and America Online subscribers are 85 percent male. Prodigy has a 30 percent female membership. But women and girls are moving more and more into cyberspace, most often in the bulletin board systems, primarily as a way to become more connected to people and to engage in meaningful discussions about issues (*not*, as was once suggested, to exchange recipes or ideas on cleaning house).

Span also warns of the recurrent messages that this is still a man's world, "The thing about cyberspace is that although sometimes it feels like a sophisticated graduate seminar or a good-natured pub, it can also, for women, feel like a walk past a construction site or a wrong turn down a dark street" (p. 24). College women report sexist comments and images sent to them. Other women are propositioned or stalked via e-mail. Many women use IDs to conceal their sex in order to protect themselves from harassment.

One creator of numerous bulletin boards sees a similarity between the frontier towns in our earlier history and what's happening on the Internet (Span 1994):

> in the on-line world, dominated by men, their language, their interests. . . . The moment a woman goes on-line, she's a target for all sorts of things . . . [on-line women] have to be like frontier women, a little tougher-skinned. . . . They have to master all kinds of skills they didn't know before. But as the numbers increase, the language changes, the subjects begin to reflect a more balanced society.

Do women in fact communicate differently on-line than men do? One researcher examined the ways women talk on the net to see what the differences were, finding that on one chat list the participants—largely female engineers, techies, and academics—used "a lot of politeness strategies to make the disagreement nonthreatening. . . . They try to build the esteem of the person they're disagreeing with." Whether this will influence the way males communicate, or even the structure of communication on the net, remains to be seen. In the meantime, women and girls are finding their way into the net and are doing so comfortably. Researchers predict that their numbers will increase as women begin to see this not as "technology" but rather as a tool for communication; as Span says, "this is expression, relationships, community, all the things women are taught to be skilled at."

Like the women in a study by EDC's Center for Children and Technology who saw technology as tools that enabled them to accomplish tasks that genuinely aided people, women concerned about making a difference are beginning to see the electronic networks as a vehicle for larger connection and for communication. One important model for such a network is the Telementoring Program at CCT, which links high school girls to female professionals in science- and technology-related fields for ongoing advice and support. The developers explain that the primary goal of the project "was to create on-line environments where young women from diverse backgrounds could safely discuss issues and engage in problem solving around conflicts they confront in science and technical courses." As they established the project, the developers found it was critical to have scenarios that describe complex issues to initiate conversation; a skilled adult facilitator who could affirm, validate, and highlight important issues that were raised by students and other adults in the forum; and skilled mentors. In fact, these are also needed in the technology classroom.

Computer Games and Violence

Males and females continue to approach technology differently (Turkle 1988, Jacobs 1994, Tarlin 1995), perhaps because of previous socialization. Turkle describes two different styles—transparent and opaque—for relating to technology. Transparent users are interested in technology for its own sake and like the power and performance of the computer. Opaque users see the computer as a means to an end—a tool for designing things that serve a purpose. For the most part, girls are more likely to be opaque users, willing to make do

with the tools available and to work toward an end. Boys, more likely to be transparent users, will try to push the limits of the technology. Researchers have also discovered that boys are less likely to watch shows or play with games overtly seen as "for girls," whereas the reverse is not true. When it comes to electronic game design, storylines tend to support both extremes, resulting in Mortal Kombat for boys and boyfriend or shopping games for girls. Both reinforce gender-role stereotypes. In addition, the message that software like Mortal Kombat send about violence as appropriate for males and victimization as appropriate for females, has dire implications for future relationships (Provenzo 1991, Silvern & Williamson 1987).

Whether it is Mortal Kombat, Total Eclipse, or the notorious Night Trap, the majority of video games are criticized for teaching and promoting violence and sexism. But the games are only creations of humans, and as Jacobs (1994) reminds us, they are a "reflection of the concerns and attitudes of the still mostly male computer-jock culture . . . and it is this culture that is designing the so-called information superhighway. The type of intuitive interface perfected in video games—you see it, you shoot it—will likely have more and more mainstream applications." If this is the present and future, it will discourage most girls and many boys from playing video games or cruising the net.

Much of the interaction with video games occurs either in video arcades or in classrooms or informal settings. Most research has looked at how girls compare to boys, with boys used as the yardstick for comparison (Inkpen et al. 1994). One recent Canadian research team looked at how girls reacted to an electronic games environment in a space with games, a wide variety of people to interact with, pen-and-paper activities, and hands-on construction. The researchers found that although girls did like to play video games, they preferred to do so at home rather than in a public space, raising the question of who girls felt controlled the public discourse (use) of the video platform. Girls tended to prefer computer games over video games. Computer games were seen as more "worthwhile," video games as mindless, as one girl explained about how she played both games ". . . those mindless games [Nintendo], I play them after playing these mind games [Carmen Sandiego]."

The sense of who owns the domain is also reflected in the fact that girls are less likely to enter into a video space if there are no other girls there—especially their friends—and are less likely to interrupt boys playing to ask for a turn. Boys however, will enter a video space and usually demand their turn. Girls for the most part gravitated to those games or activities that emphasized relationships, story, and characters and were less willing to engage in activities with no purpose other than to win.

Margaret Honey of CCT, who did her doctoral research on gender and video games, senses that the world of game playing parallels society as a whole. She argues that for boys video play provides a cathartic experience, that they find it "empowering to be successful in these games." Girls are more resistant to the pacing, the need to act without thinking, and

the constraints of the world within the game. "The problem with video games is they don't give you any voice. The fantasy is so structured, so rigid, so predetermined that there's no place to insert yourself," she says (Jacobs 1994).

Building on girls' interests, however, does not necessarily mean supporting gender-role stereotypes. Jo Sanders, coauthor of *The Neuter Computer*, cautions that sometimes teachers feel they must appeal to gender-role stereotypes to attract girls, thus reinforcing the status quo. The struggle remains how to attract girls to technology and also broaden their horizons. Sanders feels you probably can't do both at the same time. "The only solution I know to the equity trap is the incremental one of stretching girls' interests a little at a time," (Koch 1994), says Sanders. "By all means, use any software that works and that isn't insulting to get the girls to the computer, but then introduce them to all the other challenging and rewarding ways in which people use computers."

Others suggest video and computer games, such as Sim City, as a way to engage girls. As Honey (Jacobs 1994, p. 42) explains,

> They are less imbued with gross characteristics of gender. They give the player enormous amounts of control over environment. There's room for experimentation and messing around. My hunch is that girls find those games much more appealing.

Michaelene Cristine Risley, of the software company Sega, suggests that one way of bridging the gender gap is "incorporating play patterns that are interesting to girls into current games . . . more collaborative than competitive. Also the sort of repetitive progression—jump over the mushroom or start over—that is a standard feature of most games could be eliminated" (Jacobs 1994).

Paying attention to the interests and learning styles of children and then structuring programs that challenge them to learn requires constant focus. For example, CCT created Imagine after interviewing children. Imagine lets students design machines and animate the parts to show how they work. This validates girls' interest in design, requires no previous knowledge of math and science, and thus removes the game from the unconscious "male domain." Imagine does not appeal to the stereotyped ideas of what girls like, rather it gets beyond the stereotypes to the deeper interests of girls.

Opportunities for Change

The socialization of students and the discourse patterns with regard to computers in schools raise concerns about the software and computer-related activities students engage with in school. Studies confirm that girls are more likely to be engaged by software they find emotionally or intellectually stimulating, while boys are more attracted to action-

oriented, competitive games and software; and programs that appeal strongly to females are less widely used and less frequently available than programs that appeal to males (Lewis 1987). Distressingly, the research concludes that while there may be small differences in overall access to computers in schools, differences in type of use are larger (Sutton 1991). Girls are underrepresented in uses of computers—elective programming, game playing, and before- and after-school use—where the student is in control, issuing directions and observing the effects of her or his actions. This was found to be true across grade levels from elementary to high school. These patterns of difference in types of use appear to exist also for poor students, who are disproportionately African American and Hispanic (Sutton 1991). Poorer students gain most of their experience with a computer when it is in control, asking questions of the students and judging the responses to be right or wrong.

There is the need for all students, but especially girls who may have been denied these opportunities, to have access to more student-centered and student-directed uses of computers in which the control is placed in the students' hands rather than in the computer. In carefully choosing computer software and activities to be used in classrooms where students can be given more control over their experiences and interactions with computers, teachers can influence students' perceptions of computers.

For example, in a classroom investigation with the Geometric Supposer (Schwartz, Yerushalmy, and Education Development Center), a tool designed for student exploration and inquiry in geometry, students explore geometric constructions and make conjectures about the relationships that they find. The following scenario, summarized from *How to Use Conjecturing and Microcomputers to Teach Geometry* (Chazan & Houde 1989), describes a problem that students explored in a geometry class.

Students were asked to start with *any* triangle ABC, draw medians (line segments from a vertex of the triangle to the midpoint of the opposite side) from A (AD) and B (BE), and label the point of intersection of the medians (F). In addition to making their own conjectures, students were asked to examine the relationships between the areas of shapes in the figure and compare lengths of the segments that make up the two medians (AF, FD, BF, and FE). Students explored the problem in pairs; some started their investigations with equilateral triangles, while others started with acute scalene triangles. Some students explored the ratios of the parts of the medians, and another pair examined the relationships between the triangles created by the medians. The following is a list of conjectures that students made (many pairs of students found the same conjectures)

- Medians AD and BE intersect in a 2:1 ratio.
- The areas of triangles AFE and BFD are the same.
- Triangle AFB has twice the area of either triangle AFE or BFD.
- Triangle AFB and quadrilateral CEFD have the same area.

- The areas of triangles AFE and BFD are one-sixth the area of triangle ABC.
- The areas of triangle AFB and quadrilateral CEFD are one-third the area of the original triangle.

After the class conjectures were collected, the teacher facilitated a discussion and debate about these conjectures, in which students presented evidence or counterexamples to support their own theories. Contrary to traditional geometry classes, students were coming up with their own hypotheses, collecting data to support their ideas and using it to convince themselves and other classmates. This type of investigation enables students, all students, to enter into the exploration. There is not one single "right answer," but rather a diversity of ideas and strategies are encouraged.

An important part of this exploration is the discussion that accompanied it. As the teacher began a discussion about conjectures, students voted on whether a conjecture was true or false. One girl used the computer to show that a conjecture did not hold and added a counterexample. Students then discussed her offering and, after working individually for a while, another female student offered another proof. Throughout the class, students interjected comments and examples and the class ended with suggestions for students to continue the exploration on their own. Since female students were active participants in the construction of the knowledge, it would be important to further examine the role the teacher plays in facilitating a discussion that provides opportunities for females to participate equally in the public construction of that knowledge.

As illustrated above, in many ways computers are flexible and powerful tools; they can open up exploration and discussion and can be an expressive medium. As educators, we must support and help create opportunities for constructive and creative uses of technology. The distance that many women have from computers both inhibits their creativity and ultimately excludes them from making contributions in technical fields. Since, as Damarin (1989) argues, computers are eliminating many positions traditionally held by women, they have forced women to choose between routinized employment, which is often hazardous, and work that requires significantly more technical and mathematical skill than prior "women's jobs." As our society becomes increasingly technological, technical and mathematical skills for women are essential and necessary to ensure that women are not excluded from full participation. In schools, therefore, teachers need to broaden the types of experiences that students, especially girls and young women, have with computers, and also give students more choice over how they use computers to solve problems.

Collaboration and mutual support is a theme that surfaces often in the experiences of women in computer science and mathematics. Not only it is important for the learning environment to be supportive and encouraging of cooperation, attempts to increase female representation in new technologies should "avoid isolating students and simultaneously

pitting 'human' against 'machine'" (Lewis 1987). Some examples of computer-related activities that are encouraging of cooperation and creative thinking include art and design projects and problem-solving activities that encourage multiple solutions and strategies. For example, in both the *Seeing and Thinking Mathematically* curriculum unit, "Designing Spaces for People" (EDC 1992) and the *Insights Elementary Science* "Structures" module (EDC 1991), students are engaged in designing, constructing, and testing their own structures rather than just studying the geometry or science of existing buildings and structures.

Changing the content and discourse of students'—especially females'—interactions with computers, mathematics, and science does effect change in their involvement with it. "Several teaching experiences by Buerk (1981, 1985) with math-avoidant women have shown that a change in mathematical content and activities, such as the introduction of problem-posing experiences, reading about the history of mathematics, and discussions about the nature of mathematics, led women to appreciate the more relativistic aspects of mathematics and, consequently, to revise their negative images of it. Once they had achieved this, their attitudes toward the discipline became more positive, and they are able to begin to realize their unexplored mathematical abilities" (Borasi 1991). Damarin (1990) suggests that "with the modification of the language of instruction and the use of a more cooperative approach to realistic problems can come a decrease in the psychological distance of many students, especially girls and women, from the subject matter." This quote captures the sense of possibility and opportunity offered educators in rethinking the relationship of women, technology, and teaching.

Suggestions for Teachers and Parents

The following suggestions, gathered from teachers, researchers, and trainers, can help create an equitable environment in which all students can be fully engaged, critical thinkers and active citizens of a democracy that uses technology to serve the people.

1. **Examine our own attitudes**. Do we believe females are not as skilled as males in mathematics, science, or technology and do we play that out in our interactions? Do we allow male students to control the classroom discourse? Do we interact with male students more than with female students? Do we discourage risk taking and autonomous behavior in girls? Do we use challenges as a major motivator, rather than examining ways to change the discourse, by, for example, asking open-ended questions, not making immediate judgments on responses, or involving girls collectively in discussions?

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2. **Start early to prevent gender-role stereotyping**. Families can foster children's ability to take risks, and to be entranced by technology. Encourage females as well as males to explore their environment; help young girls take risks; introduce both girls and boys to action toys and team sports to increase their spatial visualization skills; provide equitable opportunities for both boys and girls to play with computers and other technology in ways that is fun for them but that also doesn't reinforce gender stereotypes. Assert how both boys and girls can do math, science, and technology work and be ready to counter the denials from children—they've already heard the other message.

3. **Watch the words we use; language is powerful**. Children as well as adults do not translate the word "man" to mean both man and woman. Nonsexist language is critical to a change in discourse, as is a shift from the language of aggression (kick, take a stab at, rip it apart). Use care not to call scientists, mathematicians, lawyers, doctors, or engineers "he" unless you are speaking about a specific individual who is male. Include examples of white women, people of color, and ethnic minorities in your descriptions of math, science, or technology. For example, include Rosalind Franklin as a key discoverer of the DNA molecule and Catherine Littlefield Greene as the inventor and marketer of the cotton "engine" (Eli Whitney *built* it for her).

4. **Shift the focus from the student to the environment**. Explore how the environment, the climate, pedagogy, and practice of the school or classroom may be creating the disparities.

5. **Support girls who are interested in technology**. Provide opportunities for them to meet and interact with other girls like themselves; connect them with adults who can mentor their interest.

6. **Introduce technology to girls in elementary school**. Provide practical technology. Create small technology centers in the classroom, close to the teacher and integrated into the room. Create special theme projects that build on different interests students have. Make sure the projects represent both boys' and girls' interests and are multicultural in content and design. Have all students do all the projects; don't allow the boys to control the selection of the projects or to do only those that they like.

7. **Provide opportunities for girls to use computers without pressure.** If girls are allowed to familiarize themselves with technology without the stress of having to talk computer talk or to push for their turns, they will be more likely to develop an affinity for computers. Girls often will use only the technology with which they are familiar and need to be encouraged to try new software—in a safe setting.

8. **Make the connection between technology and future careers at the middle school level.** Make gender equity a clear focus of career days or fairs; have middle school students visit technology labs at high schools.

9. **Bring guest speakers, especially women, into the technology classrooms.** Forge links with local business and industry so students can see and experience technology as a part of everyday life. Work to find those sites where men and women are working comfortably together. Discuss with employers the concerns about women in technology, gender equity, and workplace efforts to increase the numbers of women in technology. Involve them in efforts to change.

10. **On the high school level create more flexible course structures to enable girls to take more electives.** Schedule computer and technology classes at times that don't conflict with those classes that are popular among girls.

11. **Review the curriculum to make better education-work connections and break down stereotypes about careers for women.** For example, teach students the importance of Augusta Ada Lovelace, Grace Hopper, or Heady Lamarr in the development of modern technology.

12. **Draw on the guidance of *The Neuter Computer*** by Jo Sanders and Antonia Stone. In a national field test of this project, girls' computer participation increased by 144 percent in only one term.

13. **Connect with and support out-of-school technology programs.** Work with them to make them more inclusive and welcoming for white girls, all students of color, and poor students.

14. **Build relationships with community technology centers to help increase access for poor students.** One helpful resource is EDC's CTCNet—the Community Technology Centers' Network—with over 100 affiliate organizations. For information about CTCNet, call EDC (617) 969-7100, e-mail CTCNet@edc.org, or visit the web site at http://www.ctcnet.org

15. **Advocate for good, inclusive games and software.** Examine video games and software for overt and covert bias. What messages do they present about the role of males and females? Are they designed to include and value the voices and experiences of diverse groups of people or do they present a world view that is predominantly white, male, and middle class? Engage with your students in a critique of the software. Contact software designers and marketers to encourage them to remove offensive sexist or racist representations from the games and packaging; encourage them to design for diversity, making sure that students from all backgrounds and experiences are able to find themselves validated in the programs.

Conclusions

The issues surrounding the intersections of gender, technology, and discourse in education are complex. This paper raised a number of openings or opportunities for classroom change, including increasing the opportunities for girls to engage in technology-related activities, working with more collaborative activities, giving students' more control over the activities that they work on, building upon connections with girls' interest and experience, changing patterns of discourse, and giving girls' opportunities to have a public presence.

As we develop a research agenda concerning technology, we must examine what it is in the experience of students that encourages their interest in technology and which of their experiences can enhance the development and exploration of technology itself. We need to examine more fully the question of which students—which girls and which boys—succeed and why. Technology and computer use must be examined within the context of what is taught to whom, how it is taught, and how it is experienced.

The message that computers are for boys is a culture-bound one. But the implications of this message must not be overlooked. It is ironic that, since the introduction of microcomputers into schools, the number of women applying to computer science courses has decreased (Wajcman 1991). If computers are being placed in mathematics and science classes and taught by math and science teachers—often male—we are creating the cultural assumption that computers belong with mathematics—and males—rather than creating the assumption that computers are a tool for creativity in a wide range of practical and abstract endeavors.

The reason for our efforts are clear, as Span (1994) reminds us:

> people of either gender can still live meaningful lives without computers
> I don't think that will be true for my daughter though, or any of our daughters. . . . Perhaps they won't need to be whiz-bang programmers (though it wouldn't hurt). But they can't afford to see computers as toys for boys, to see ignorance as feminine, to wring their hands over the keyboard and worry that they'll break something.

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